

## **DETAILED ACTION**

### ***Status of Prosecution***

The final Office Action dated 1/7/2011 is hereby withdrawn - since all rejections and objections therein have been overcome or withdrawn - and replaced herewith.

Upon further consideration of the pending claims and available art, the previous indication of allowable subject matter is hereby withdrawn. In view of the correcting amendments, the previous indefiniteness rejection is withdrawn.

Note that the non-final Office Action dated 7/9/2010 treated independent claims which did not require multiple nanotubes, a network or crosslinking, and was a proper rejection. Subsequent amendments added those limitations to the independent claims. This action contains new grounds of rejection necessitated by amendment and is made final, per MPEP § 706.07(a).

### ***Election/Restrictions***

Claims 4-10, 14-16, 29, 33-40, 42 and 43 stand withdrawn per 37 CFR 1.142(b) as drawn to nonelected species, there being no allowable generic or linking claim. Election was made without traverse in the reply dated 4/19/2010.

### ***Response to Arguments***

The arguments filed 3/2/2011 were considered, but are essentially moot.

The arguments filed 9/28/2010 were fully reconsidered and found partially persuasive and partially unpersuasive, as follows.

The arguments (§ I) that "Haruyama does not anticipate amended claims..." are moot in view of the new grounds of rejection, but are also not necessarily convincing. While Haruyama does not disclose the specific chemical bonds disclosed in the instant specification and recited in certain dependant claims, the current independent claims recite "a network structure in which...nanotubes mutually cross-link" which seems to encompass multiwalled nanotubes (one can fairly say that each wall is a nanotube, and they all mutually cross-link to create a network, or a multiwall nanotube).

The arguments (§ II) that Tour (US 2007/0297216) does not qualify as prior art are convincing. The Tour reference itself does not have a prior art filing date, but relies on related applications. The publication of US 11/190,525 discloses a network as claimed, but is not prior art relative to the filing of the instant application. The publication of 10/090211 does not disclose nanotubes; provisional application 60/272895 does not disclose nanotubes or the claimed network.

The arguments (§ III) requesting rejoinder have been considered. However, as no claims are currently indicated as allowable, rejoinder is not applicable at this time.

### ***Claim Objections***

Claim 45 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim.

### ***Claim Rejections - 35 USC § 103***

Statute 35 U.S.C. § 103(a) is the basis for obviousness rejections made herein:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims ~~acknowledged~~ are rejected under 35 U.S.C. 103(a) as being obvious in view of Haruyama (Cite No. 3 on IDS of Aug 19 2009 and Park (US 7,008,758).

**RE claim 1**, Haruyama discloses a rectifying device, comprising (Fig 1a):

a pair of electrodes (Au contact / Al substrate); and

a carrier transporter (MW CNT) arranged between the pair of electrodes and composed of multiple carbon nanotubes (each wall of a MW CNT is a CNT),

characterized in that a first connection configuration between one electrode of the pair of electrodes and the carrier transporter and a second connection configuration between the other electrode of the pair of electrodes and the carrier transporter are made different from each other in such a manner that a first interface between the one electrode and the carrier transporter and a second interface between the other electrode and the carrier transporter have different barrier levels (one tunnel barrier),

wherein the carrier transporter is formed by a carbon nanotube structure having a network structure in which the multiple carbon nanotubes mutually cross-link (each wall of the MW CNT is a CNT, which all "cross-link" to form a "network" that is the MW CNT).

Haruyama might be viewed as lacking the claimed network and cross-link.

Park is analogously directed to "electronic devices of nano-size" (col 1 ln 60) and teaches a network structure (monolayer or pattern, col 2 ln 46) in which the multiple carbon nanotubes mutually cross-link (col 2 ln 49) and may be applied to nearly any substrate (col 5 ln 63-66) and easily patterned (col 10 ln 18-22).

It would have been obvious to a person having ordinary skill in the art at the time the invention was made that a device similar to that of Haruyama be prepared using the modified nanotubes of Park; at least to allow flexibility in production and patterning.

**RE claim 11**, Haruyama discloses a material for the one electrode (Al) and a material for the other electrode (Au) are made different "in such a manner that" the first interface and the second interface have different barrier levels (quoted recitation does not structurally distinguish per MPEP § 2114, claim language considered met since Haruyama discloses different materials and different barrier levels).

**RE claim 12**, Haruyama discloses the materials composing the one electrode (Al) and the other electrode (Au) each independently comprise at least one metal selected from the group consisting of aluminum, silver, copper, silicon that is made conductive, gold, platinum, titanium, zinc, nickel, tin, magnesium, indium, chromium, manganese, iron, lead, palladium, tantalum, tungsten, molybdenum, vanadium, cobalt, hafnium, and lanthanum, or an alloy thereof.

**RE claim 13**, Haruyama discloses the material composing the other electrode (Au) comprises at least one metal selected from the group consisting of gold, titanium, iron, nickel, tungsten, silicon that is made conductive, chromium, niobium, cobalt, molybdenum, and vanadium, or an alloy thereof.

**RE claim 17**, Park discloses the carbon nanotube structure is obtained by chemically bonding functional groups bonded to multiple carbon nanotubes to form cross-linked sites (e.g., col 2 ln 49).

**RE claim 18**, the combination of Haruyama and Park discloses the multiple carbon nanotubes mainly comprise single-wall carbon nanotubes (encompassed).

**RE claim 19**, the combination of Haruyama and Park discloses the multiple carbon nanotubes mainly comprise multi-wall carbon nanotubes.

**RE claim 20**, Park discloses the cross-linked sites each comprise a chemical structure as claimed (e.g., col 2 ln 53 – col 3 ln 18).

**RE claim 21**, Park discloses the cross-linked sites each comprise a chemical structure as claimed (e.g., col 2 ln 53 – col 3 ln 18).

**RE claim 22**, Park discloses a solution containing multiple carbon nanotubes to which functional groups are bonded to form the cross-linked sites by chemically bonding the functional groups of the multiple carbon nanotubes (e.g., col 3 lns 40, 45).

**RE claim 23**, Park discloses solution containing multiple carbon nanotubes to which functional groups are bonded (col 3 ln 40-67) and a cross-linking agent capable of prompting a cross-linking reaction (e.g., col 2 ln 53 – col 3 ln 25, col 4 ln 30) with the functional groups is cured to subject the functional groups and the cross-linking agent to a cross-linking reaction, to thereby form the cross-linked sites (col 2 ln 45-50).

**RE claim 24**, Park discloses the cross-linking agent comprises a non-self-polymerizable cross-linking agent (col 2 ln 53 – col 3 ln 25, col 4 ln 30, col 4 ln 30).

**RE claim 25**, Park discloses the cross-linked sites have structures formed by chemical bonding of the functional groups.

**RE claim 26**, the combination of Haruyama and Park discloses all the structure required by “a reaction that forms the chemical bonding comprises a reaction selected

from the group consisting of dehydration condensation, a substitution reaction, an addition reaction, and an oxidative reaction" per MPEP § 2113.

**RE claim 27**, Haruyama discloses carrier transporter is laminar, and the carbon nanotube structure is patterned into a predetermined shape.

**RE claim 28**, Haruyama discloses the barrier level at the first interface is higher than the barrier level at the second interface; and

a width of a surface of the one electrode is equal to or greater than a width of the carrier transporter at an interface between the one electrode and the carrier transporter.

**RE claim 30**, Haruyama discloses comprising a sealing member (e.g., alumina) for sealing at least the first interface against external air.

**RE claim 31**, Haruyama discloses a flexible base body (Al substrate) having the rectifying device formed on its surface.

If objective evidence is made of record to establish that the Al substrate of Haruyama would not be understood as flexible, then the following applies.

Official notice is taken that nanotube based devices such as that of Haruyama are conventionally formed in arrangements including that claimed, which would have been obvious to the ordinarily skilled artisan at the time of the instant invention.

**RE claim 32**, Haruyama discloses a method of manufacturing a rectifying device including (e.g, Fig 1a):

a base body (e.g., alumina);

a pair of electrodes (Au contact / Al substrate); and

a carrier transporter (MW CNT) arranged between the pair of electrodes and composed of multiple carbon nanotubes (each wall of a MW CNT is a CNT),

characterized by comprising a connection configuration forming step of forming a first connection configuration between one electrode of the pair of electrodes and the carrier transporter and a second connection configuration between the other electrode of the pair of electrodes and the carrier transporter into different configurations in such a manner that a first interface between the one electrode and the carrier transporter and a second interface between the other electrode and the carrier transporter have different barrier levels (single tunnel barrier),

wherein the carrier transporter is formed by a carbon nanotube structure having a network structure in which the multiple carbon nanotubes mutually cross-link (each wall of the MW CNT is a CNT, which all "cross-link" to form a "network" that is the MW CNT).

Haruyama might be viewed as lacking the claimed network and cross-link.

Park is analogously directed to "electronic devices of nano-size" (col 1 ln 60) and teaches a network structure (monolayer or pattern, col 2 ln 46) in which the multiple carbon nanotubes mutually cross-link (col 2 ln 49) and may be applied to nearly any substrate (col 5 ln 63-66) and easily patterned (col 10 ln 18-22).

It would have been obvious to a person having ordinary skill in the art at the time the invention was made that a device similar to that of Haruyama be prepared using the modified nanotubes of Park; at least to allow flexibility in production and patterning.

**RE claim 41**, Haruyama discloses the connection configuration forming step includes a step of forming the pair of electrodes from different materials.

**RE claim 44**, Haruyama discloses the carrier transporter is formed by a network structure in which multiple carbon nanotubes which are not chemically bonded together are entangled (e.g., nested as in the MWCNT).

**RE claim 45**, Park discloses the carrier transporter is formed by a carbon nanotube structure having a network structure in which the multiple carbon nanotubes mutually cross-link (col 2 ln 49).

**RE claim 46**, the combination of Haruyama and Park encompasses that prior to the connection formation forming step, a carrier transporter forming step of forming the carrier transporter, characterized in that the carrier transporter forming step includes:

a supplying step of supplying the surface of the base body with multiple carbon nanotubes having functional groups (col 5 ln 62); and

a cross-linking step of cross-linking the functional groups via cross-linked sites to form the carbon nanotube structure having the network structure (col 6 ln 20).

**RE claim 47**, Park discloses the supplying step includes an applying step of applying a solution containing the carbon nanotubes having the functional groups to the surface of the base body; and the carbon nanotube structure is filmy (col 5 ln 65).

**RE claim 48**, Haruyama with Park encompasses that the multiple carbon nanotubes mainly comprise single-wall carbon nanotubes.

**RE claim 49**, Haruyama discloses the multiple carbon nanotubes mainly comprise multi-wall carbon nanotubes.



**RE claim 50**, Park discloses supplying a cross-linking agent (col 2 ln 53 – col 3 ln 25, col 4 ln 30 – col 5 ln 45) for cross- linking the functional groups to the surface of the base body.

**RE claim 51**, Haruyama in view of Tour discloses the cross-linking agent comprises a non-self-polymerizable cross-linking agent (col 2 ln 53 – col 3 ln 25, col 4 ln 30 – col 5 ln 45).

**RE claim 52**, Park discloses the functional groups comprise at least one functional group selected from the recited group (e.g., col 2 ln 53 - col 3 ln 18), and the cross-linking agent is capable of prompting a cross-linking reaction with the selected functional group (col 2 ln 48, col 6 ln 20).

**RE claim 53**, Park discloses the cross-linking agent comprises at least one cross-linking agent selected from the group consisting of a polyol, a polyamine, a polycarboxylic acid, a polycarboxylate, a polycarboxylic acid halide, a polycarbodiimide, and a polyisocyanate (e.g., col 2 ln 53 – col 3 ln 25, col 4 ln 30 - col 5 ln 45); and each of the functional groups is capable of prompting a cross-linking reaction with the selected cross-linking agent (col 6 ln 20).

**RE claim 54**, Park discloses the functional groups comprise at least one functional group selected from the group consisting of -OH, -COOH, -C(=O)R (where R represents a substituted or unsubstituted hydrocarbon group), -COX (where X represents a halogen atom), -NH<sub>2</sub>, and -NCO (col 2 ln 53 – col 3 ln 18);

the cross-linking agent comprises at least one cross-linking agent selected from the group consisting of a polyol, a polyamine, a polycarboxylic acid, a polycarboxylate, a

polycarboxylic acid halide, a polycarbodiimide, and a polyisocyanate (col 2 In 53 – col 3 In 18); and

a combination of the selected functional group and the selected cross-linking agent is capable of prompting a mutual cross-linking reaction (col 6 In 20).

**RE claim 55**, Pak discloses each of the functional groups comprises -COOR (col 2 In 53 – col 3 In 25).

**RE claim 56**, Park discloses the cross-linking agent comprises a polyol (e.g., col 2 In 53 – col 3 In 25, col 4 In 30 - col 5 In 45).

**RE claim 57**, Pak discloses the cross-linking agent comprises at least one selected from the group consisting of glycerin, ethylene glycol, butenediol, hexynediol, hydroquinone, and naphthalenediol (col 2 In 53 – col 3 In 25, col 4 In 30 - col 5 In 45).

**RE claim 58**, Park discloses a reaction for cross-linking the functional groups in the cross-linking step comprises a reaction for chemically bonding the functional groups (col 2 In 29, col 6 In 20).

**RE claim 59**, Park discloses the supplying step includes supplying an additive that forms the chemical bonding of the functional groups to the surface of the base body (col 2 In 53 – col 3 In 25, col 4 In 30 - col 5 In 45).

**RE claim 60**, Park discloses the reaction comprises dehydration condensation and the additive comprises a condensation agent.

If it can be shown that this claimed reaction would not be understood as encompassed by Haruyama and Park, the following applies.

Official notice is taken the claimed reaction would have been obvious to one of ordinary skill in the art at the time of the invention.

**RE claim 61**, Park discloses the functional groups comprise at least one functional group selected from the group consisting of -COOR (where R represents a substituted or unsubstituted hydrocarbon group), -COOH, -COX (where X represents a halogen atom), -OH, -CHO, and -NH<sub>2</sub> (col 2 ln 53 – col 3 ln 25).

**RE claim 62**, Park discloses each of the functional groups comprises -COOH (col 2 ln 53 – col 3 ln 25).

**RE claims 63-72**, Park either discloses or renders obvious all these claims (e.g., col 2 ln 53 – col 3 ln 35, col 4 ln 30 – col 5 ln 25).

If it can be shown that any of these claimed limitations are not disclosed or rendered obvious by Park, then the following applies.

Official notice that parameters such as specified in these claims are known and were in use for the intended purpose and would have been obvious to one of ordinary skill in the art at the time of the invention.

**RE claim 73**, Park discloses the carrier transporter is formed by a carbon nanotube structure having a network structure in which the multiple carbon nanotubes mutually cross-link (col 2 ln 49); and

a patterning step of patterning the carbon nanotube structure into a pattern corresponding to the carrier transporter (col 6 ln 25-27) **RE claim 73**, Haruyama in view of Tour discloses the carrier transporter is formed by a carbon nanotube structure having a network structure in which the multiple carbon nanotubes mutually cross-link;

and the method further comprises a patterning step of patterning the carbon nanotube structure into a pattern corresponding to the carrier transporter.

**RE claims 74-80**, Park discloses the patterning step comprises a step in which the carbon nanotube structure in a region on the surface of the base body other than a pattern corresponding to the carrier transporter is subjected to removal, whereby the carbon nanotube structure is patterned into a pattern corresponding to the carrier transporter (col 6 ln 25-27).

If it can be shown that any of these claimed limitations are not disclosed or rendered obvious by Park, then the following applies.

Official notice that parameters such as specified in these claims are known and were in use for the intended purpose and would have been obvious to one of ordinary skill in the art at the time of the invention.

#### ***Cited Art***

Duan (US 7,851,841) discloses CNT networks (Figs 1, 8A) in devices (Fig 2).

Horiuchi (US 2002/0172639) discloses CNT networks & devices (Figs 2, 8, 10).

Niu (US 2003/0039604) discloses other methods of modification of CNTs with functional groups (e.g., ¶s 27, 72, 73) to be used in cross-linking reactions such as those claimed. Niu may be used to substantiate official notices taken.

Many additional references disclose other methods of modification of CNTs with functional groups to be used in cross-linking reactions such as those claimed, and may be used to substantiate official notices taken, such as:

Park (US 2008/0153991)	Tour (US 7,892,517)
Khabashesku (US 7,452,519)	Cooper (US 2010/0282668)
Curran (US 7,713,508)	Niu (US 7,070,753).

Several references should be kept in mind as potentially raising double patenting issues if allowance is sought in the present application, including:

US 7,695,769	US 7,646,588	US 7,452,828
US 7,244,374	US 7,244,373	US 7,217,374

### ***Allowable Subject Matter***

In view of the newly discovered art, the previously indicated allowable subject matter is no longer considered allowable.

It seems that Fig 1(a) of the instant invention, in which the nanotubes directly contact two electrodes of different material and therefore form the claimed different barrier levels has not been found in the prior art. If proper language is found, this feature could end up being the basis of allowance.

In view of the many references which specify different functional groups and cross-linking agents and reactions, the method of cross-linking seems unlikely to result in allowance, but should be considered if expressed very specifically.

### ***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of time extension per 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andrew O. Arena whose telephone number is 571-272-5976. The examiner can normally be reached on M-F 8:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne A. Gurley can be reached on 571- 272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. For more info about PAIR, see <http://pair-direct.uspto.gov>. For questions PAIR access, contact the Electronic Business Center at 866-217-9197 (toll-free). For assistance from a USPTO Customer Service Rep or access to the automated info system, call 800-786-9199 or 571-272-1000.

/Andrew O. Arena/  
Examiner, Art Unit 2811  
25 March 2011

/Lynne A. Gurley/  
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